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Case report

Aortic dissection and cocaine use

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ABSTRACT

Most of the cocaine - deaths are said to be related to cardiovascular complications. This paper addresses a rather infrequent complication of chronic cocaine use, represented by the aortic dissection. The case in point pertains to a 45-year-old, caucasian male, substance abuser who suffered an aortic dissection following the use of cocaine. Blood concentrations of cocaine and benzoylecgonine were considered not to be within a potentially toxic range.

1. Introduction

In the E.U. about 13 million people have, at least once in their lifetime, made use of cocaine. About 500 cocaine-related sudden deaths were reported from 12 Union countries during the years 2008–2009. Most of the deaths are said to be related to the use of this substance and to chronic neurological and cardiovascular complications.[1] The main neurological complications related to cocaine use are headache, seizures and stroke, while the cardiovascular complications, which are much more frequent, are hypertension, atherosclerosis,[2] coronary spasm, myocardial ischemia, myocarditis and arrhythmias.[3] This paper addresses a rather infrequent complication of chronic cocaine use, represented by the aortic dissection.

This is a very serious medical condition and characterized by high mortality. If untreated, in fact, aortic dissection is associated with an increased mortality from 1 to 2% per hour during the first 24–48 h, of 33% in the first 24 h, 50% within 48 h, 75% within the first 2 weeks and 90% within one year.[4,5]

The factors predisposing to the formation of an aortic aneurysm are degenerative changes in the smooth muscle and elastic tissue of aortic wall, with development, at times, of cysts that are the basis of most cases. However, the clinical condition most commonly associated with degeneration of the media is hypertension, which is present in more than 2/3 of cases. Other causes include hereditary connective tissue disorders such as Marfan syndrome and Ehlers-Danlos syndrome, congenital cardiovascular malformation, the atherosclerosis.

2. Case history

The subject was a normally developed Caucasian male, 45 years old, 177 cm tall weighing 76 kg.

The subject, according to information collected, was a cocaine abuser.

The body was found by a relative, sitting on a couch in his house. Investigators found cocaine on a table and noticed the presence of the substance on the right nostril. The autopsy was performed 24 h after the discovery of the corpse.

3. Autopsy findings

The external examination of the corpse highlighted subungual cyanosis of the hands.

The autopsy showed a pulmonary edema associated with congestion.

The pericardial sac, undamaged, contained about 500 cc of fluid blood and clotted blood around the heart. The heart had a normal volume; the endocardioum was thin; the myocardium was dark red and his consistency was increased. The coronary arteries were of normal size and hypoelastic with some atheromatous plaques.

The aorta was affected by widespread sclerotic and atheromatous plaques; in the ascending tract was observed a lesion, with irregular infiltrating margins of tunica intima, extending to the outer surface of the wall, and in its full-thickness.

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4. Histological findings

Histological examination showed the detection of congestion and edema in the brain and lungs.

Histologic tests of the heart showed the presence of few polymorphocyte in the vessels and increased intercellular and perivascular fibro-sclerotic component, and myocardiosclerosis.

Histological tests of the aorta, carried out on all levels did not reveal any sign of infection, vasculitis or other pathological abnormalities. Histological tests of coronary arteries showed the same pattern.

5. Toxicological findings

During the autopsy rates of blood and urine, that were subjected to chemical and toxicological examinations were taken. In a sample of urine immunochemical analysis that tested positive for the presence of urinary metabolite of cocaine (benzoylecgonine) were performed. The rates of blood and urine were extracted in solid phase (SPE columns Bond Elut Certify - Varian, Inc. - USA) after dilution with phosphate buffer (0.1 M pH = 6) and the addition of deuterated internal standard (cocaine-d3 and benzoylecgonine-d3). The extracted solutions were then evaporated to dryness, and added with 50 μg of BSTFA, derivatized at 80 °C for 3 h. After cooling, the solutions were analyzed by gas chromatography with mass detector (HP 6890 to 5973) to search for specific ions of cocaine and benzoylecgonine.

The analysis showed the presence of both substances, the quantitative analysis were respectively 1.6 μg/ml and 0.4 μg/ml in blood and 5.0 μg/ml and 28.7 μg/ml in urine.

A full toxicological analysis was performed on body fluids taken during the autopsy; the analysis did not show other exogenous substances of toxicological interest.

6. Discussion

In this case the autopsy, evidenced a ruptured dissecting aneurysm of the ascending aorta in its intrapericardial portion and the presence of about 500 cc of blood in the pericardial sac with a fluid component of clotted blood on the outer surface of the heart, identify the cause of death in a “cardiac tamponade”.

In terms of pathogenesis, in the aortic dissection, a “spontaneous” tearing of intima and then of the middle coat causes an outflow of blood from the lumen to the newly formed space, with the increase of the original diameter of the aorta; this explains the definition “dissecting aneurysm”. The aorta does not appear Ectasic, as in a “true” aneurysm, but restricted in the interior, while the blood stretches to the outer layers of the wall. The false lumen is created in the outer layers of media, which are very thin and therefore fragile, and endanger the integrity of the vessel which is therefore at higher risk of rupture.

Therefore, increased blood pressure, acting on this organic substrate can cause, as shown by the above considerations, the rupture of a dissecting aneurysm. An important but not exclusive role, however, seems to be played by hypertension or conditions that may favor the onset. With reference to the results of the chemical-toxicological tests, which showed the presence of cocaine in the blood but also in the urine, we wish to emphasize, in this case, the role that cocaine can play in cardiac deaths associated with the use of “toxic” and in particular in rare cases of aortic dissection. The disease has a multifactorial etiology, which involves several factors, including hypertension, cigarette smoking, atherosclerosis cocaine-induced necrosis of the media and hemodynamic stress.[6]

Cocaine (benzoylmethylecgonine, C17H21NO4) is an alkaloid extracted from leaf of Erythroxilon coca; the plant usually grows in South America. Generally it is available as a hydrochloride salt or free base (“crack”).

When applied locally, the substance has an anesthetic effect due to its ability to inhibit the permeability to sodium during depolarization, causing the onset and synaptic transmission. If systemically administered, its effects are mediated through changes in synaptic transmission. Cocaine blocks the presynaptic re-uptake of norepinephrine and dopamine, resulting in an excess of these neurotransmitters at postsinaptic receptor.[7] In short, cocaine acts as a powerful Sympathomimetic agent. These phenomena predispose cardiovascular manifestations of cocaine use such as vasoconstriction, hypertension, tachycardia and thrombogenesis. Vasoconstriction is caused by stimulation of alpha-receptors, an increased production of endothelin and decreased production of nitric oxide.[8,9]

The pathogenic mechanism that underlies the use of cocaine-induced aortic dissection is still unknown and under investigation. Physiologically, the aorta is able to withstand large fluctuations in pressure. Factors contributing to the development of an acute aortic aneurysm include increased stress on the wall vessel, usually produced by hypertension, aortic intima destruction and structural alterations of the vessel, especially in the tunica media.

The sudden and severe elevation of blood pressure produces an increase in the “shear” stress on the vessel. It is believed that this phenomenon helps to produce destruction of intimate and penetration of the column of blood within the media and anterograde or retrograde spread of hematoma.[10] Some studies have shown other possible mechanisms by which the “toxic” may lead to impairment of the aortic wall. Su et al., through the study of smooth muscle cells of aorta in rats, showed concentration-dependent action of cocaine at that level trough induction of apoptosis.[11]

Another study showed that cocaine also contributes to the development of cystic degeneration of the media and the consequent impairment of the wall.[12] Bigi et al.[13] found a deterioration of elastic properties of the aorta in patients with a history of cocaine use of at least 10 years. It is now clear that the “toxic” also leads to a premature development of the atherosclerotic process,[14] due probably, to endothelial damage which is manifested mainly in the aorta.[15] This phenomenon also observed in this case.

In conclusion, in our case, it is possible to assume an important role that cocaine plays in the cause of death .We can assume that the “toxic” has acted, according to a chronic use, through a dual mode. The chronic intake has contributed to the development of the cardiovascular disease; on this substrate the aneurysm developed.

The necropsy data allow us, in fact, to identify typical features of degeneration of the cardiovascular system, represented by the atherosclerotic process in the aorta and coronary, by myocardiosclerosis, and by hypoelasticity in the myocardium and vessels. The intake of cocaine determined, on this degenerative pathology, a high and sudden increase of blood pressure, causing intimal lesion and ultimately of aortic dissection.

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Conflict of interest statement
None declared.

References

1. European Monitoring Centre for Drugs and Drug Addiction. http://www.emcdda.europa.eu/publications/joint-publications/cocaine. (Accessed 24 01 11).
2. Norris KC, Thornhill-Joynes M, Robinson C, Strickland T, Alperson BL, Witana SC, et al. Cocaine use, hypertension, and end-stage renal disease. *Am J Kidney Dis* 2001;**38**:523–8.

3. Kliner RA, Hale S, Alker K, Rezkalla S. The effects of acute and chronic cocaine use on the heart. *Circulation* 1992;**85**:407–19.
4. DeSanctis RW, Doroghazi RM, Austen WG, Buckley MJ. Aortic dissection. *N Engl J Med* 1987;**317**:1060–7.
5. Suzuki T, Mehta RH, Ince H, Nagai R, Sakomura Y, Weber F, et al. Clinical profiles and out- comes of acute type B aortic dissection in the current era: lessons from the international registry of aortic dissection (IRAD). *Circulation* 2003;**108**(Suppl 1):II312–317.
6. Singh S, Trivedi A, Adhikari T, Molnar J, Arora R, Khosla S. Cocaine-related acute aortic dissection: patient demographics and clinical outcomes. *Can J Cardiol* 2007;**23**(14):1131–4.
7. Lange RA, Hillis LD. Cardiovascular complications of cocaine use. *N Engl J Med* August 2, 2001;**345**(No.5).
8. Vongpatanasin W, Mansour Y, Chavoshan B, Arbique D, Victor RG. Cocaine stimulates the human cardiovascular system via a central meccanismo of action. *Circulation* 1999;**100**:497–502.
9. Kalsner S, Nickerson M. Mechanism of cocaine potentiation of response to amines. *Br J Pharmacol* 1969;**35**:428–39.
10. Davies MJ, Treasure T, Richardson PD. The patogenesis of spontaneous arterial dissection. *Heart* 1996;**75**:434–5.
11. Su J, Li J, Li W, Altura BT, Altura BM. Cocaine induces apoptosis in primary cultured rat aortic vascular smooth muscle cells: possible relationship to aortic dissection, atherosclerosis, and hypertension. *Int J Toxicol* 2004;**23**: 233–7.
12. Ihling C, Szombathy T, Nampoothiri K, Haendeler J, Beyersdorf F, Uhl M, et al. Cystic medial degeneration of the aorta is associated with p53 accumulation, Bax upregulation, apoptotic cell death, and cell proliferation. *Hearth* 1999;**82**(3):286–93.
13. Bigi MA, Aslani A, Mehrpour M. Effect of chronic cocaine abuse on the elastic properties of aorta. *Echocardiography* 2008;**25**:308–11.
14. Kolodgie FD, Virmani R, Cornhill JF, Herderick EE, Smialek J. Increase in atherosclerosis and adventitial mast cells in cocaine abusers: an alternative mechanism of cocaine-associated coro- nary vasopasm and thrombosis. *J Am Coll Cardiol* 1991;**17**:1553–60.
15. Darke S, Kaye S, Duflou J. Cocaine-related fatalities in New South Wales. Australia 1993–2002. *Drug Alcohol Depend* 2005;**77**:107–14.